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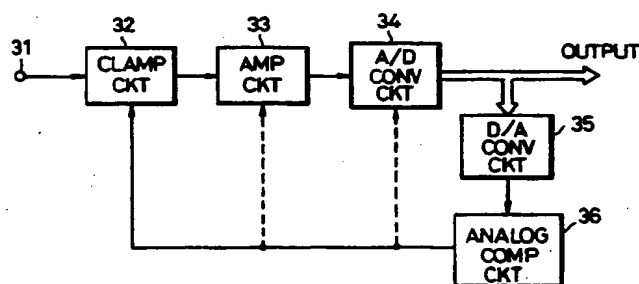
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(54) Analogue-to-digital converting apparatus for video signals.

(57) An analog-to-digital converting apparatus comprises a clamping circuit (32) for clamping a reference level of an input analog video signal supplied thereto, an amplifying circuit (33) for amplifying an output signal of the clamping circuit, an analog-to-digital converting circuit (34) for generating a digital video signal by subjecting an output signal of the amplifying circuit (33) to an analog-to-digital conversion, and a control signal generating circuit (35, 36) for generating at least for the duration of a horizontal synchronizing signal of the input analog video signal a control signal responsive to a difference between the value of the output digital video signal of the analog-to-digital converting circuit (34) and the value of a preset reference signal. The control signal is supplied to one or two out of the clamping circuit (32), the amplifying circuit (33), and the analog-to-digital converting circuit (34) to variably control one or two out of a clamping voltage of the clamping circuit (32), an offset voltage of the amplifying circuit (33), and a first reference voltage of the analog-to-digital converting circuit (34) so that the value of the difference becomes a minimum.



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ANALOG-TO-DIGITAL CONVERTING APPARATUS

The present invention generally relates to analog-to-digital converting apparatuses, and more particularly to an analog-to-digital converting apparatus which subjects an input analog video signal to an analog-to-digital conversion and generates a digital video signal having a predetermined quantization number of bits per picture element.

10

An analog-to-digital converting apparatus (hereinafter simply referred to as an A/D converting apparatus) is used when transmitting an analog video signal in the form of a digital video signal having a predetermined quantization number of bits. A first example of a conventional A/D converting apparatus generally comprises a first buffer amplifier, a coupling capacitor, a second buffer amplifier, a switching circuit, a clamping voltage source, an analog-to-digital (A/D) converter, and a reference voltage source. An input analog video signal such as a composite video signal, a luminance signal, a color difference signal, or one of three primary color signals, is passed through the first buffer amplifier and the coupling capacitor and is supplied to the second buffer amplifier. The switching circuit is turned ON during a horizontal blanking period of the input analog video signal, and during this time period, a potential at a connection point of the coupling capacitor, the switching circuit, and the second buffer amplifier is fixed to a clamping voltage which has a predetermined level and is obtained from the clamping voltage source. During time periods other than the horizontal blanking period, the switching circuit is turned OFF, and the analog video

1 signal obtained through the coupling capacitor is supplied
as it is to the second buffer amplifier. However, in this
state, the terminal voltage of the coupling capacitor is
5 clamping voltage, and an analog video signal having the
clamping voltage as a reference D.C. voltage is supplied
to the second buffer amplifier. An analog video signal
obtained from the second buffer amplifier is subjected to
an analog-to-digital conversion in the A/D converter which
10 is determined of the dynamic range thereof responsive to a
reference voltage obtained from the reference voltage
source. As a result, a digital video signal having a
predetermined quantization number of bits per picture
element is generated.

15 As a second example of a conventional A/D converting
apparatus, there is an A/D converting apparatus which is
provided with a differential amplifier instead of the
second buffer amplifier of the first example of the
20 conventional A/D converting apparatus described above. In
this case, the analog video signal obtained through the
coupling capacitor and the clamping voltage obtained from
the switching circuit are both applied to one input
terminal of the differential amplifier, and an output
25 signal of the differential amplifier is supplied to the
A/D converter. An offset voltage obtained from an offset
voltage source is applied to the other input terminal of
the differential amplifier.

30 A third example of a conventional A/D converting apparatus
is provided with an analog comparator and a second
switching circuit in addition to the circuit elements of
the second example of the conventional A/D converting

1 apparatus described above. In this case, the level of the
output signal of the differential amplifier is compared
with the level of a predetermined reference voltage in the
analog comparator, and an output signal of the analog
5 comparator is supplied to the second switching circuit.
The second switching circuit is turned ON during the
horizontal blanking period, and the output signal of the
analog comparator is supplied to the clamping voltage
source or the offset voltage source so as to variably
10 control an output voltage thereof.

The brightness, the light and shade and the like of an
optical display on a display device are determined by the
signal level of the analog video signal with respect to a
15 reference D.C. voltage (reference level). Accordingly, it
is of much importance to control the reference level. In
the case where the analog video signal is the composite
video signal, the reference level is the pedestal level.
On the other hand, in the case where the analog video
20 signal is the luminance signal, the color difference
signal or the primary color signal, the reference level is
the signal level in the horizontal blanking period. In
addition, the quality of the gradation of the video signal
after the A/D conversion is proportional to the
25 quantization number of bits of the digital video signal,
and in order to obtain a satisfactory gradation, it is
essential that the reference level is set to an optimum
level with respect to the dynamic range of the A/D
converter.

30 Hence, in the first example of the conventional A/D
converting apparatus, the output clamping voltage of the
clamping voltage source is manually adjusted so that the

- 1 reference level is set to the optimum level with respect
to the dynamic range of the A/D converter. In the second
example of the conventional A/D converting apparatus, the
clamping voltage is fixed and the output offset voltage of
5 the offset voltage source is manually adjusted so that the
reference level is set to the optimum level. Further, in
the third example of the conventional A/D converting
apparatus, in order to set the reference level to the
optimum level, the output voltage of the clamping voltage
10 source or the offset voltage source is adjusted so that a
level difference between the output signal of the
differential amplifier and the predetermined reference
voltage becomes a minimum.
- 15 However, in the first and second examples of the
conventional A/D converting apparatus, there are problems
in that it takes time to perform the adjustment and that
the adjusting operation is troublesome to perform because
the adjusting operation is performed manually. On the
20 other hand, in the first through third examples of the
conventional A/D converting apparatus, the adjustment is
only performed in the analog circuit part of the
apparatus. For this reason, there is another problem in
that it is impossible to obtain a satisfactory adjusting
25 precision and adjusting range due to an error introduced
by the temperature characteristics of the circuit elements
which constitute the A/D converter, an adjusting error and
the like.
- 30 Accordingly, it is a general object of the present
invention to provide a novel and useful A/D converting
apparatus in which the problems described heretofore are
eliminated.

1 Another and more specific object of the present invention
is to provide an A/D converting apparatus comprising a
clamping circuit supplied with an input analog video
signal, an amplifying circuit supplied with an output
5 signal of the clamping circuit, an A/D converting circuit
for subjecting an output signal of the amplifying circuit
to an A/D conversion, a digital-to-analog (D/A) converting
circuit for subjecting an output signal of the A/D
converting circuit to a digital-to-analog (D/A)
10 conversion, and an analog comparing circuit for detecting
a difference between the value of an output signal of the
D/A converting circuit and the value of a predetermined
reference signal and for controlling by an output signal
of the analog comparing circuit one or two out of a
15 clamping voltage of the clamping circuit, an offset
voltage of the amplifying circuit, and a reference voltage
which determines the dynamic range of the A/D converting
circuit. According to the A/D converting apparatus of the
present invention, the analog comparing circuit supplies
20 to one or two out of the clamping circuit, the amplifying
circuit, and the A/D converting circuit a control signal
responsive to an error introduced due to the temperature
characteristics of the circuit elements which constitute
the A/D converting circuit, an adjusting error and the
25 like. Hence, it is possible to compensate for the error
introduced due to the temperature characteristics of the
circuit elements which constitute the A/D converting
circuit, the adjusting error and the like, and the
reference level of the input analog video signal can
30 constantly and automatically be adjusted to a
predetermined level. As a result, it is possible to set
the reference level to an optimum level with respect to
the dynamic range of the A/D converting circuit.

1 Still another object of the present invention is to
provide an A/D converting apparatus comprising a clamping
circuit supplied with an input analog video signal, an
amplifying circuit supplied with an output signal of the
5 clamping circuit, an A/D converting circuit for subjecting
an output signal of the amplifying circuit to an A/D
conversion, and a digital comparator for detecting a
difference between the value of an output digital signal
of the A/D converting circuit and the value of a
10 predetermined digital reference value and for controlling
by an output signal of the digital comparator one or two
out of a clamping voltage of the clamping circuit, an
offset voltage of the amplifying circuit, and a reference
voltage which determines the dynamic range of the A/D
15 converting circuit. According to the A/D converting
apparatus of the present invention, the digital comparator
supplies to one or two out of the clamping circuit, the
amplifying circuit, and the A/D converting circuit a
control signal which is obtained by comparing the output
20 digital signal of the A/D converting circuit with the
digital reference value, without converting the output
digital signal of the A/D converting circuit into an
analog signal. Thus, in addition to the advantageous
features described before, it is possible to adjust the
25 reference level of the input analog video signal by an
extremely stable circuit.

Other objects and further features of the present
invention will be apparent from the following detailed
30 description when read in conjunction with the accompanying
drawings.

FIG.1 is a system block diagram showing a first

1 example of the conventional A/D converting apparatus;
FIG.2 is a system block diagram showing a second
example of the conventional A/D converting apparatus;
FIG.3 is a system block diagram showing a third
5 example of the conventional A/D converting apparatus;
FIG.4 is a system block diagram showing a first
embodiment of the A/D converting apparatus according
to the present invention;
FIG.5 is a system block diagram showing an embodiment
10 of a concrete construction of the block system shown
in FIG.4;
FIG.6 is a system block diagram showing a second
embodiment of the A/D converting apparatus according
to the present invention; and
15 FIG.7 is a system block diagram showing an embodiment
of a concrete construction of the block system shown
in FIG.6.

FIG.1 is a system block diagram showing a first example of
20 the conventional A/D converting apparatus. In FIG.1, an
input analog video signal (that is, a composite video
signal, a luminance signal, a color difference signal, or
a primary color signal) is applied to an input terminal
11. The input analog video signal is passed through a
25 buffer amplifier 12 and a coupling capacitor 13 and is
supplied to a buffer amplifier 14. On the other hand, a
clamping pulse which assumes a predetermined level for
every horizontal blanking period of the input analog video
signal is applied to an input terminal 15. The clamping
30 pulse is supplied to a switching circuit 16, and the
switching circuit 16 is turned ON during a time period in
which the clamping pulse is supplied thereto.
Accordingly, a potential at a connection point of the

1 coupling capacitor 13, the switching circuit 16, and the
buffer amplifier 14 is fixed to a preset clamping voltage
which has a predetermined level and is obtained from a
clamping voltage source 17, during a time period in which
5 the switching circuit 16 is turned ON (during the
horizontal blanking period). During time periods other
than the horizontal blanking period, in which time periods
no clamping pulse is applied to the terminal 15, the
switching circuit 16 is turned OFF. Hence, the analog
10 video signal obtained through the coupling capacitor 13 is
supplied as it is to the buffer amplifier 14 during the
time periods other than the horizontal blanking period,
but since the terminal voltage of the coupling capacitor
13 is charged up to a level which is the same as that of
15 the clamping voltage, the analog video signal is supplied
to the buffer amplifier 14 with the clamping voltage as
the reference D.C. voltage (reference level).

The analog video signal obtained through the buffer
20 amplifier 14 is supplied to an A/D converter 18 wherein
the signal is subjected to an A/D conversion. Hence, a
digital video signal having a predetermined quantization
number of bits per picture element is generated from the
A/D converter 18 and is obtained through output terminals
25 20_1 through 20_m . A reference voltage for determining the
dynamic range of the A/D converter 18 is supplied to the
A/D converter 18 from a reference voltage source 19.

FIGS.2 and 3 are system block diagrams showing second and
30 third examples of the conventional A/D converting
apparatus, respectively. In FIGS.2 and 3, those parts
which are the same as those corresponding parts in FIG.1
are designated by the same reference numerals and

1 description thereof will be omitted. In the conventional
apparatus shown in FIG.2, the analog video signal obtained
through the coupling capacitor 13 and the clamping voltage
obtained from the switching circuit 16 are applied to one
5 input terminal of a differential amplifier 21. An offset
voltage obtained from an offset voltage source 22 is
applied to the other input terminal of the differential
amplifier 21. An output signal of the differential
amplifier 21 is supplied to the A/D converter 18.

10

In the conventional apparatus shown in FIG.3, the level of
the output analog video signal of the differential
amplifier 21 is compared with the level of a predetermined
reference voltage obtained from a reference voltage source
15 24 in an analog comparator 23, and an output signal of the
analog comparator 23 is supplied to a switching circuit
25. The switching circuit 25 is turned ON during a time
period in which the clamping pulse obtained from the input
terminal 15 is supplied thereto. Hence, during the time
20 period in which the clamping pulse is applied to the input
terminal 15, the switching circuit 25 selectively passes
the output signal of the analog comparator 23.
Accordingly, the output signal of the analog comparator 23
is supplied to the clamping voltage source 17 or the
25 offset voltage source 22 to variably control the output
voltage thereof.

As described before, the brightness, the light and shade
and the like of an optical display on a display device are
30 determined by the signal level of the analog video signal
with respect to the reference level. Accordingly, it is
of much importance to control the reference level. In the
case where the analog video signal is the composite video

1 signal, the reference level is the pedestal level. On the
other hand, in the case where the analog video signal is
the luminance signal, the color difference signal or the
primary color signal, the reference level is the signal
5 level in the horizontal blanking period.

In addition, the quality of the gradation of the video
signal after the A/D conversion is proportional to the
quantization number of bits of the digital video signal,
10 and in order to obtain a satisfactory gradation, it is
essential that the D.C. reference level is set to an
optimum level with respect to the dynamic range of the A/D
converter 18. Moreover, in a transmission system which
does not transmit digital data during horizontal and
15 vertical blanking periods in which the level of the
digital video signal becomes equal to a specific value as
is well known and only transmits digital data during video
periods other than the horizontal and vertical blanking
periods so as to reduce the transmitting quantity of the
20 digital data and reduce the memory capacity of a digital
memory which stores the digital video signal, it is
essential to set the D.C. reference level with an
extremely high accuracy in order to reproduce the
gradation in the dark part in the case of the composite
25 video signal, the luminance signal or the primary color
signal and in order to reproduce the white balance in the
low saturation part in the case of the color difference
signal or the primary color signal.

30 Hence, in the first example of the conventional apparatus
shown in FIG.1, the output clamping voltage of the
clamping voltage source 17 is manually adjusted so that
the reference level is set to the optimum level with

- 1 respect to the dynamic range of the A/D converter 18. In
the second example of the conventional apparatus shown in
FIG.2, the clamping voltage is fixed and the output offset
voltage of the offset voltage source 22 is manually
5 adjusted so that the reference level is set to the optimum
level. Further, in the third example of the conventional
apparatus shown in FIG.3, in order to set the reference
level to the optimum level, the output voltage of the
clamping voltage source 17 or the offset voltage source 22
10 is adjusted so that a level difference between the output
signal of the differential amplifier 21 and the
predetermined reference voltage obtained from the
reference voltage source 24 becomes a minimum.
- 15 However, in the first and second examples of the
conventional apparatus shown in FIGS.2 and 3, there are
problems in that it takes time to perform the adjustment
and that the adjusting operation is troublesome to perform
because the adjusting operation is performed manually. On
20 the other hand, in the first through third examples of the
conventional apparatus shown in FIGS.1 through 3, the
adjustment is only performed in the analog circuit part of
the apparatus. For this reason, there is another problem
in that it is impossible to obtain a satisfactory
25 adjusting precision and adjusting range due to an error
introduced by the temperature characteristics of the
circuit elements which constitute the A/D converter 18, an
adjusting error and the like.
- 30 Accordingly, the A/D converting apparatus according to the
present invention feeds back the output digital signal of
the A/D converter in order to adjust the reference level
to the optimum level, and the problems described

1 heretofore are eliminated in the apparatus according to
the present invention.

FIG.4 is a system block diagram showing a first embodiment
5 of the A/D converting apparatus according to the present
invention. In FIG.4, a reference level of an input analog
video signal which is applied to an input terminal 31 and
supplied to a clamping circuit 32, is clamped in the
clamping circuit 32. An output signal of the clamping
10 circuit 32 is passed through an amplifying circuit 33 and
is supplied to an A/D converting circuit 34 wherein the
signal is subjected to an A/D conversion. An output
digital video signal of the A/D converting circuit 34 is
supplied to a digital-to-analog (D/A) converting circuit
15 35 wherein the signal is subjected to a digital-to-analog
(D/A) conversion. An output signal is obtained from the
D/A converting circuit 35 at least for the duration of the
horizontal synchronizing signal. An analog comparing
circuit 36 compares the output signal of the D/A
20 converting circuit 35 with a preset reference signal. An
output signal of the analog comparing circuit 36, which is
responsive to a difference between the compared signals,
is supplied as a control signal to one or two out of the
clamping circuit 32, the amplifying circuit 33, and the
25 A/D converting circuit 34. As a result, one or two out of
the clamping voltage of the clamping circuit 32, the
offset voltage of the amplifying circuit 33, and the
reference voltage for determining the dynamic range of the
A/D converting circuit 34 is controlled responsive to the
30 control signal. FIG.4 shows a case where the control
signal is supplied to the clamping circuit 32, however,
the the control signal may be supplied to one or two out
of the clamping circuit 32, the amplifying circuit 33, and

1 the A/D converting circuit 34 as indicated by a solid
signal line and phantom signal lines.

The A/D converting apparatus shown in FIG.4 operates so
5 that the one or two out of the clamping voltage, the
offset voltage, and the reference voltage is variably
controlled and the difference detected in the analog
comparing circuit 36 becomes a minimum. In the present
embodiment, the output digital video signal of the A/D
10 converting circuit 34 is converted into an analog signal
at least for the duration of the horizontal synchronizing
signal, and the value of the analog signal is compared
with the value of the preset reference signal. The
control signal which is responsive to the difference
15 between the values of the compared signals, is then
supplied to one or two out of the clamping circuit 32, the
amplifying circuit 33, and the A/D converting circuit 34.
For this reason, the analog comparing circuit 36 generates
a control signal which includes the error introduced due
20 to the temperature characteristics of the circuit elements
which constitute the A/D converting circuit 34, the
adjusting error and the like.

FIG.5 is a system block diagram showing an embodiment of
25 the concrete construction of the block system shown in
FIG.4. In FIG.5, those parts which are the same as those
corresponding parts in FIG.4 are designated by the same
reference numerals. In FIG.5, the input terminal 31 is
coupled to one input terminal of a differential amplifier
30 45 by way of a buffer amplifier 41 and a coupling
capacitor 42. A connection point between the coupling
capacitor 42 and the differential amplifier 45 is coupled
to a clamping voltage source 44 by way of a switching

1 circuit 43. The buffer amplifier 41, the coupling
capacitor 42, the switching circuit 43, and the clamping
voltage source 44 constitute the clamping circuit 32. An
output clamping voltage of the clamping voltage source 44
5 is variably controlled responsive to a control signal. A
clamping pulse having a pulse width corresponding to the
horizontal blanking period of the input analog video
signal is applied to an input terminal 40. The switching
circuit 43 is only turned ON for the duration of the pulse
10 width of the clamping pulse, and the switching circuit 43
is turned OFF during other time periods. Accordingly, as
described before in conjunction with FIGS.1 through 3, the
reference level of the input analog video signal in the
horizontal blanking period (that is, the pedestal level in
15 the case of the composite video signal and the signal
level in the horizontal blanking period in the case of the
color difference signal or the primary color signal) is
clamped to a predetermined D.C. voltage obtained from the
clamping voltage source 44 and is supplied to the
20 differential amplifier 45.

The differential amplifier 45 constitutes the amplifying
circuit 33 together with an offset voltage source 46. The
differential amplifier 45 amplifies the output analog
25 video signal of the clamping circuit 32 and supplies the
amplified signal to an A/D converter 47. The A/D
converter 47 constitutes the A/D converting circuit 34
together with a reference voltage source 48. The
reference voltage source 48 generates a reference voltage
30 which determines the dynamic range of the A/D converter
47, and the output reference voltage of the reference
voltage source 48 is variably controlled responsive to a
control signal. For example, the A/D converter 47 is a

1 non-feedback comparator type converter comprising $2^n - 1$
comparators each of which is supplied to one input
terminal thereof with a voltage which is obtained by
dividing the reference voltage from the reference voltage
5 source 48 by 2^n in a voltage dividing resistor circuit and
supplied to the other input terminal thereof with the
analog video signal, and a decoder supplied with outputs
of the comparators, where n is a natural number. However,
the A/D converter 47 is not limited to the non-feedback
10 comparator type converter.

For example, a digital video signal having a quantization
number of eight bits per picture element, is generated
from the A/D converter 47 and is supplied to a circuit
15 (not shown) in a subsequent stage through output terminals
 37_1 through 37_m . On the other hand, the output digital
video signal of the A/D converter 47 is also supplied to a
D/A converter 49 wherein the digital video signal is
converted into an analog video signal and supplied to a
20 switching circuit 50. The switching circuit 50 is turned
ON only during the horizontal blanking period responsive
to the clamping pulse from the input terminal 40, and is
turned OFF during other time periods. Hence, the output
analog video signal of the D/A converter 49 is selectively
25 obtained through the switching circuit 50 only during the
horizontal blanking period, and this analog video signal
is supplied to a capacitor 51 so as to charge the
capacitor 51. The D/A converter 49, the switching circuit
50, and the capacitor 51 constitute the D/A converting
30 circuit 35. The terminal voltage of the capacitor 51 is
applied to one input terminal of an analog comparator 52.
The value of the output signal of the D/A converter 49
during the horizontal blanking period is originally known

1 in advance, and the D/A conversion need not be carried out
with respect to all gradations.

5 The analog comparator 52 constitutes the analog comparing
circuit 36 together with a reference voltage source 53.
The analog comparator 52 detects a difference between the
terminal voltage of the capacitor 51 (that is, the analog
value obtained by subjecting the output digital video
10 signal of the A/D converter 47 to the D/A conversion) and
a preset reference voltage obtained from the reference
voltage source 53. An output signal of the analog
comparator 52, which is responsive to the detected
difference, is supplied as the control signal to one or
two out of the clamping voltage source 44, the offset
15 voltage source 46, and the reference voltage source 48.
As a result, the reference level of the analog video
signal in the horizontal blanking period is automatically
adjusted to the reference voltage preset in the reference
voltage source 53, and the reference level is set to the
20 optimum level with respect to the dynamic range of the A/D
converter 47.

Next, a description will be given with respect to a second
embodiment of the A/D converting apparatus according to
25 the present invention. FIG.6 is a system block diagram
showing the second embodiment of the A/D converting
apparatus according to the present invention. In FIG.6,
those parts which are the same as those corresponding
parts in FIG.4 are designated by the same reference
30 numerals and description thereof will be omitted. In
FIG.6, a digital comparing circuit 59 detects a difference
between the value of the output digital video signal of
the A/D converting circuit 34 at least for the duration of

- 1 the horizontal synchronizing signal and a preset digital
reference value, and generates a signal responsive to the
detected difference. The output signal of the digital
comparing circuit 59 is supplied as a control signal to
5 one or two out of the clamping circuit 32, the amplifying
circuit 33, and the A/D converting circuit 34. In the
present embodiment, the A/D converting apparatus operates
so that one or two out of the clamping voltage of the
clamping circuit 32, the offset voltage of the amplifying
10 circuit 33, and the reference voltage of the A/D
converting circuit 34 is variably controlled and the
detected difference in the digital comparing circuit 59
becomes a minimum.
- 15 According to the present embodiment, the value of the
output digital video signal of the A/D converting circuit
34 is compared as it is with the preset digital value at
least for the duration of the horizontal synchronizing
signal, and the control signal responsive to the
20 difference between the two values is supplied to one or
two out of the clamping circuit 32, the amplifying circuit
33, and the A/D converting circuit 34. As in the case of
the first embodiment described before, the control signal
includes the error introduced due to the temperature
25 characteristics of the circuit elements which constitute
the A/D converting circuit 34, the adjusting error and the
like.

Next, a description will be given with respect to an
30 embodiment of the concrete construction of the block
system shown in FIG.6 by referring to FIG.7. In FIG.7,
those parts which are the same as those corresponding
parts in FIGS.5 and 6 are designated by the same reference

1 numerals and description thereof will be omitted. In
FIG.7, the output digital video signal of the A/D
converting circuit 34 is supplied to a digital comparator
60. The digital comparator 60 compares the value of the
5 digital video signal with a preset reference code (preset
digital value) obtained from a reference code generating
circuit 61. For example, a commercially available
integrated circuit such as a magnitude comparator LS682
manufactured by Texas Instruments of the United States can
10 be used for the digital comparator 60. The digital
comparing circuit 59 is constituted by the digital
comparator 60, the reference code generating circuit 61,
and a control voltage generating circuit 62. The clamping
pulse from the input terminal 40 is applied to an enable
15 terminal of the digital comparator 60, and the difference
between the compared values is only detected during the
horizontal blanking period. In addition, in actual
practice, the reference code generating circuit 61 may be
a group of switches coupled to the digital comparator 60
20 and the preset reference code may be supplied to the
digital comparator 60 by turning ON predetermined switches
out of the group of switches.

The difference between the compared values is supplied to
25 the control voltage generating circuit 62 from the digital
comparator 60, and is converted into a control voltage
responsive to the difference. The control voltage
generated from the control voltage generating circuit 62
is supplied as the control signal to one or two out of the
30 clamping voltage source 44, the offset voltage source 46,
and the reference voltage source 48, so as to variably
control one or two out of the clamping voltage, the offset
voltage, and the reference voltage. It is also possible

1 to apply the clamping pulse from the input terminal 40 to
the control voltage generating circuit 62 so that the
control voltage is generated only during the horizontal
blanking period.

5

Therefore, according to the present embodiment, the
reference level of the input analog video signal during
the horizontal blanking period with respect to the dynamic
range of the A/D converter 47 is automatically adjusted to
10 the optimum level as in the case of the first embodiment
described before. Further, the manufacturing cost of the
circuit employed in the present embodiment is considerably
low, but it is still possible to obtain stable and desired
precision.

15

In each of the embodiments described heretofore, when
converting an input luminance signal into a digital signal
having a quantization number of eight bits per picture
element, the blanking level of the luminance signal in the
20 horizontal blanking period is set to an 8-bit value "10"
in hexadecimal. On the other hand, when converting an
input color difference signal into a digital signal having
a quantization number of eight bits per picture element,
the blanking level of the color difference signal in the
25 horizontal blanking period is set to an 8-bit value "80"
in hexadecimal, which 8-bit value "80" is a center value.
When the data in the output digital signal of the A/D
converter 47 in the horizontal blanking period assumes a
predetermined value ("10" in the case of the luminance
30 signal and "80" in the case of the color difference
signal), the clamping voltage is maintained constant as it
is, for example. The clamping voltage is increased when
the data assumes a value smaller than the predetermined

1 value, and the clamping voltage is decreased when the data
assumes a value larger than the predetermined value. As a
result, it is possible to carry out the A/D conversion
with a constant blanking level.

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The present invention is not limited to the first and
second embodiments described heretofore, and for example,
a blanking pulse or a horizontal synchronizing signal may
be used instead of the clamping pulse. It is possible to
10 employ other circuit arrangements as long as the analog
comparing circuit 36 or the digital comparing circuit 59
can detect a difference between the value of the signal
with the value of preset reference signal at least for the
duration of the horizontal synchronizing signal and
15 generate an output signal responsive to the detected
difference.

Further, the present invention is not limited to these
embodiments, but various variations and modifications may
20 be made without departing from the scope of the present
invention.

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1 Claims:

1. An analog-to-digital converting apparatus comprising
clamping means (32) for clamping a reference level of an
5 input analog video signal supplied thereto, amplifying
means (33) for amplifying an output signal of said
clamping means, and analog-to-digital converting means
(34) for generating a digital video signal by subjecting
10 an output signal of said amplifying means to an analog-to-
digital conversion, characterized in that there is
provided control signal generating means (35, 36; 59) for
generating at least for the duration of a horizontal
synchronizing signal of said input analog video signal a
control signal responsive to a difference between the
15 value of the output digital video signal of said
analog-to-digital converting means (34) and the value of a
preset reference signal; and that said control signal is
supplied to one or two out of said clamping means (32),
said amplifying means (33), and said analog-to-digital
20 converting means (34) to variably control one or two out
of a clamping voltage of said clamping means, an offset
voltage of said amplifying means, and a first reference
voltage of said analog-to-digital converting means so that
the value of said difference becomes a minimum.

25 2. An analog-to-digital converting apparatus as claimed
in claim 1, characterized in that said control signal
generating means (35, 36) comprises digital-to-analog
converting means (35) for generating at least for the
30 duration of the horizontal synchronizing signal an analog
signal which is obtained by subjecting the output digital
signal of said analog-to-digital converting means to a
digital-to-analog conversion, and analog comparing means

1 (36) for comparing the value of an output analog signal of
said digital-to-analog converting means with the value of
a preset reference signal and for generating a control
signal responsive to a difference between the compared
5 values.

3. An analog-to-digital converting apparatus as claimed
in claim 2, characterized in that said digital-to-analog
converting means (35) comprises a digital-to-analog
10 converter (49) for subjecting the output digital signal of
said analog-to-digital converting means to a digital-to-
analog conversion, a switching circuit (50) for passing an
output signal of said digital-to-analog converter for at
least the duration of said horizontal synchronizing
15 signal, and a capacitor (51) which is supplied with an
output signal of said switching circuit and charged
thereby.

4. An analog-to-digital converting apparatus as claimed
20 in claim 2, characterized in that said digital-to-analog
converting means (35) comprises a digital-to-analog
converter (49) for subjecting the output digital signal of
said analog-to-digital converting means to a digital-to-
analog conversion, a switching circuit (50) for passing an
25 output signal of said digital-to-analog converter for at
least the duration of said horizontal synchronizing
signal, and a capacitor (51) which is supplied with an
output signal of said switching circuit and charged
thereby, and said analog comparing means comprises an
30 analog comparator (52) supplied with a terminal voltage of
said capacitor and a second reference voltage for
generating as said control signal a voltage responsive to
a difference between the voltages supplied thereto.

- 1 5. An analog-to-digital converting apparatus as claimed
in claim 1, characterized in that said control signal
generating means (59) comprises digital comparing means
(59) for generating at least for the duration of said
5 horizontal synchronizing signal a control signal
responsive to a difference between the value of the output
digital signal of said analog-to-digital converting means
and a preset digital reference value.
- 10 6. An analog-to-digital converting apparatus as claimed
in claim 5, characterized in that said digital comparing
means (59) comprises a digital comparator (60) for
generating at least for the duration of said horizontal
synchronizing signal an error signal responsive to a
15 difference between the value of the output digital signal
of said analog-to-digital converting means and said preset
digital reference value, and a control signal generating
circuit (62) for generating a control signal responsive to
the output error signal of said digital comparator.
- 20 7. An analog-to-digital converting apparatus as claimed
in claim 6, characterized in that said control signal
generating circuit generates said control signal only for
the duration of said horizontal synchronizing signal.

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FIG. 1 PRIOR ART

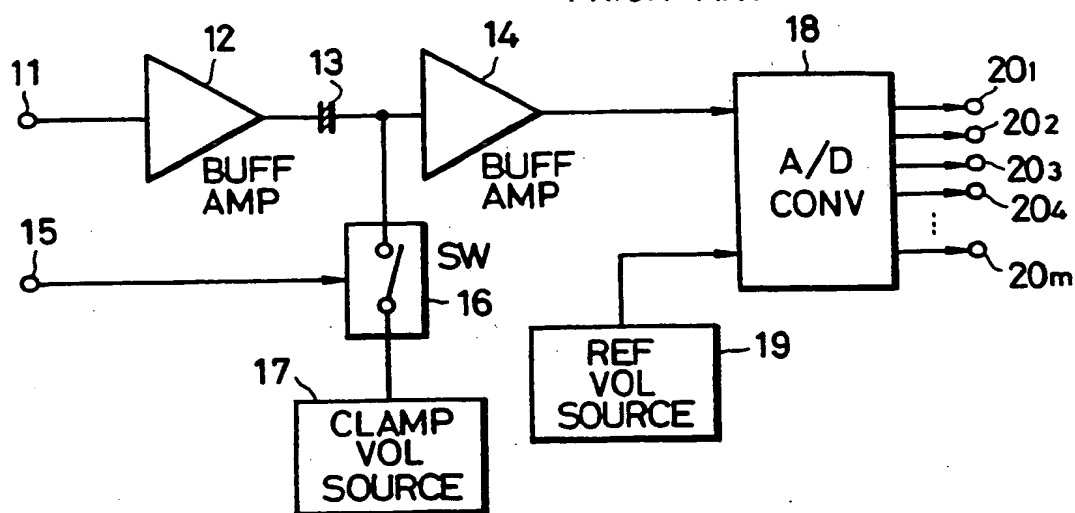


FIG. 2 PRIOR ART

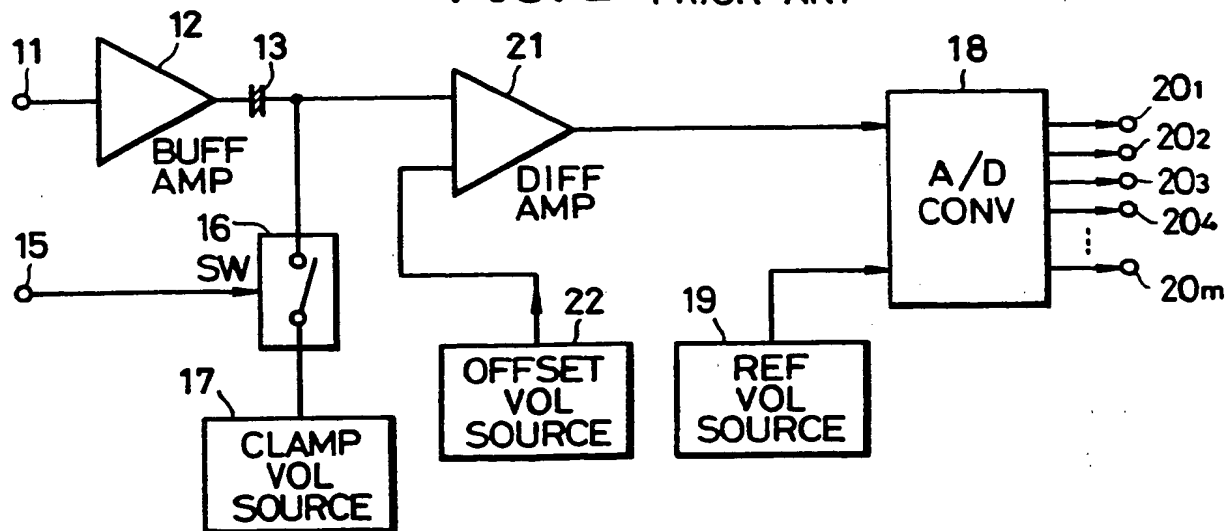


FIG. 3 PRIOR ART

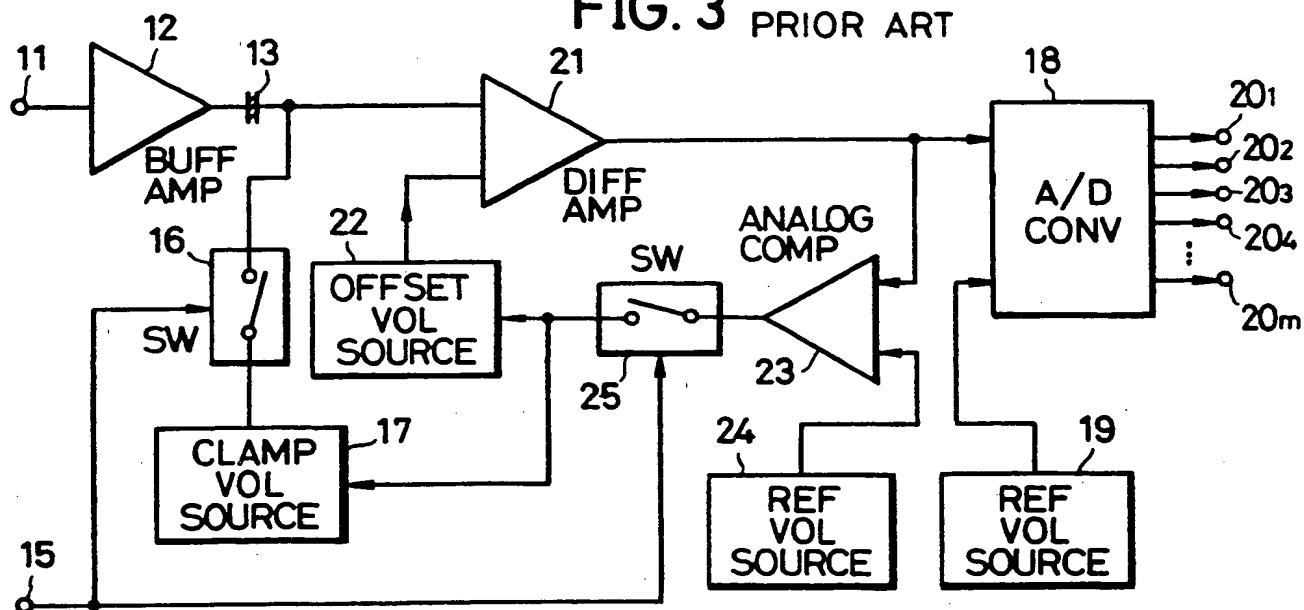


FIG. 4

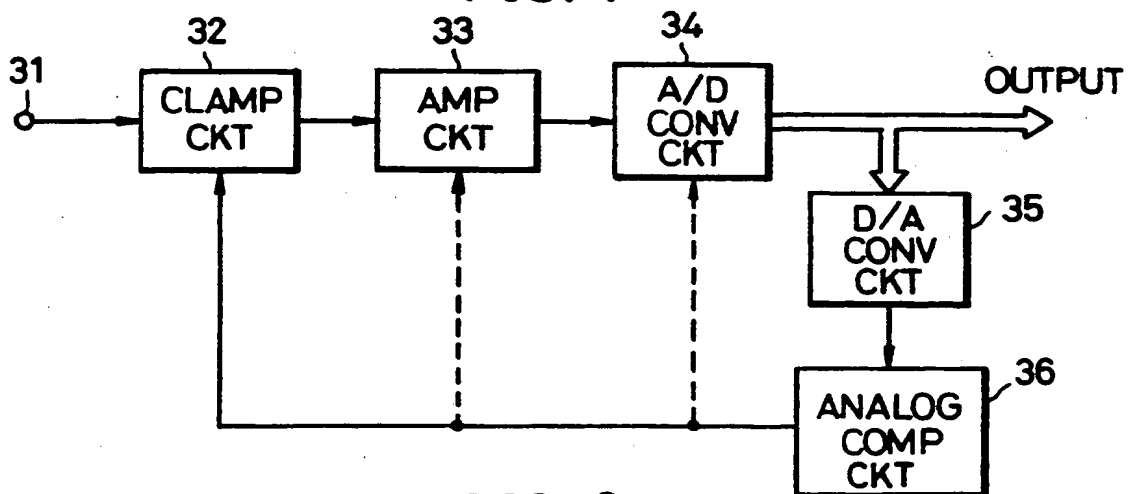


FIG. 6

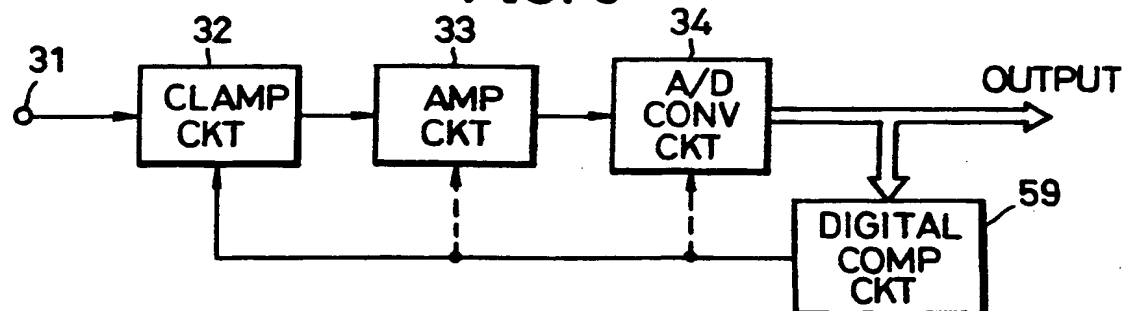


FIG. 5

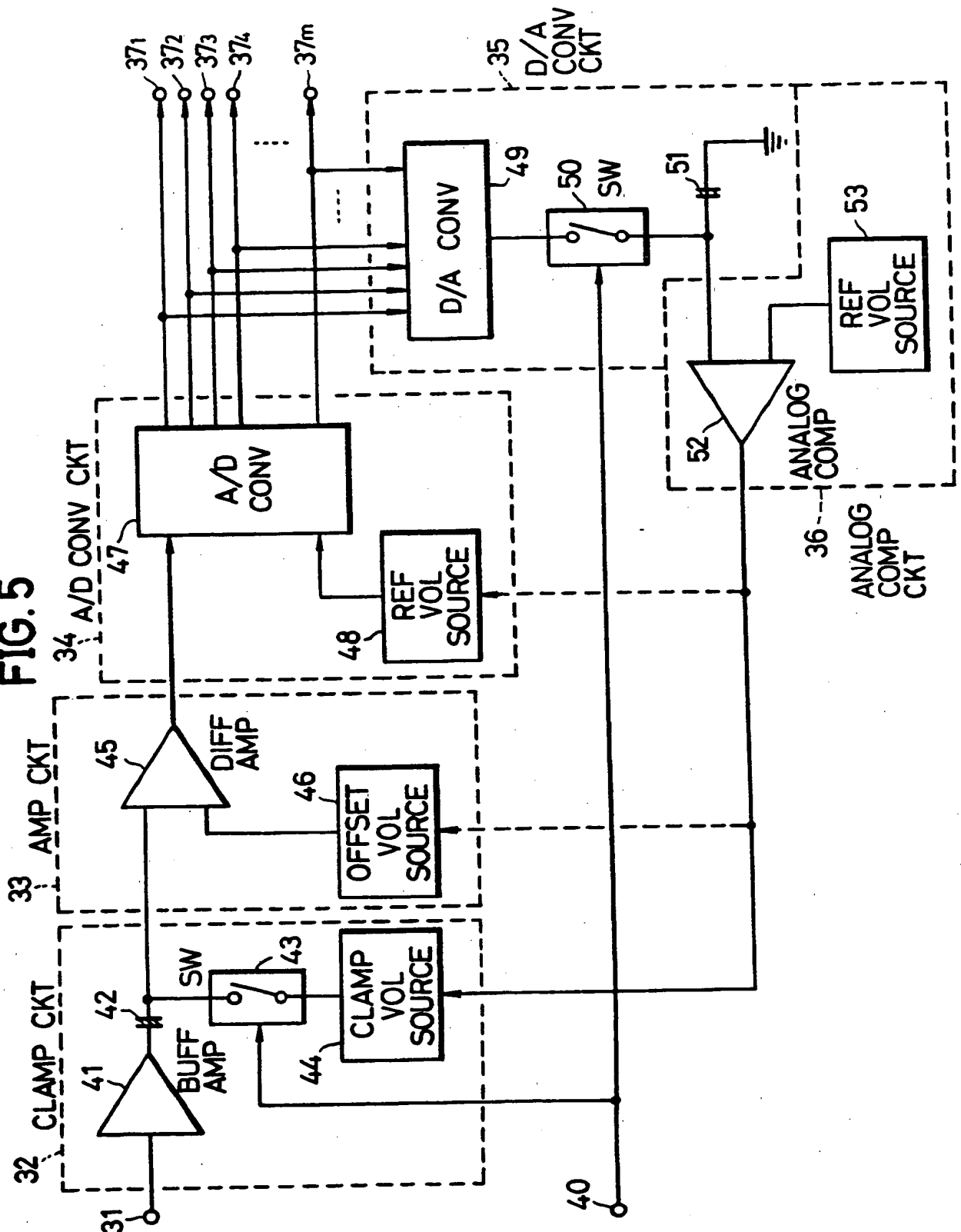


FIG. 7

